Wireless Microphones

An Overview for Local 16 Employees

By

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RF Basics

- Transmitter
- Receiver
- Carrier Wave
- FM-Frequency Modulation
- Frequency Range
  - VHF
  - UHF
- Diversity
- Intermodulation
- Squelch
- Tone Key and Digital Code Squelch

Wireless mics use radio frequencies as carrier waves to transmit sound signals from the transmitter to the receiver. Both the transmitter and receiver need to be tuned to the same frequency. The sound signals are modulations of the carrier wave of frequency and amplitude, know as FM.

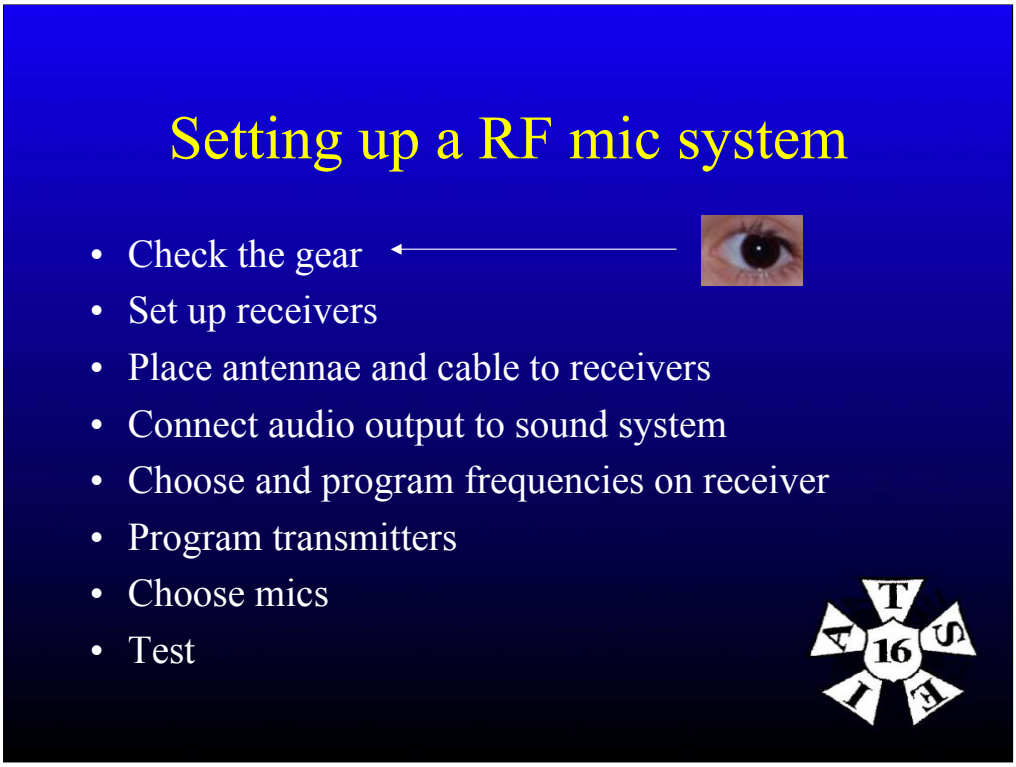
The 2 bands of frequency commonly used are VHF and UHF. VHF is 30 to 300 megahertz and UHF is 300 to 3000 megahertz. VHF has better bandwidth, thus fidelity. Because of radio congestion in the VHF range in cities, UHF has become popular for wireless mics. In the US, the UHF band with used for wireless mics are also used by television stations. Because of this it is important to be aware of the UHF television channels in the area.

Diversity is a tuner that uses 2 antennae to receive the same signal and then selects which antennae is receiving the strongest signal.

Intermodulation distortion is caused by the harmonics of radio waves.

Squelch is a circuit that mutes the audio when the radio transmission drops below a certain threshold. The lower the threshold, the longer the range of the transmitter (or mic in our case), but the more noisy the transmission becomes. The higher threshold is less noisy, but the range is shortened.

Key squelch is circuitry which gates open the audio signal when it receives the “key” signal, either a particular tone or digital signal. Thus eliminates the sound of unwanted transmissions.



Overview of talk.

I will refer mostly to the Shure UHF and Sony UHF 800 throughout the rest of this presentation. There are a lot of other brands, but these 2 are the most popular in our line of work. In the interest of time, I will not go over other brands and models.

Antennae and Cable

Cable

Always use 50 ohm cable with radio microphone systems.

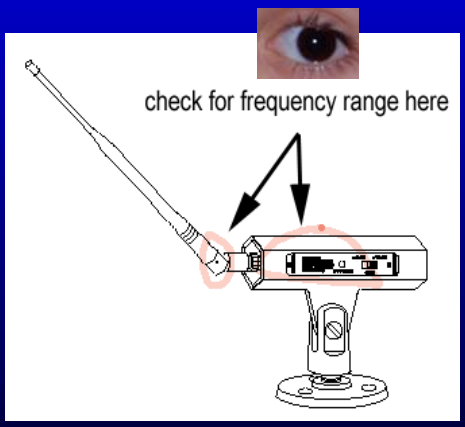
Cable Type and Length

CABLE TYPE	30% RANGE REDUCTION	50% RANGE REDUCTION
LO COST RG-58	15’	30’
QUALITY RG-58	24’	48’
LOW COST RG-8	31’	63’
QUALITY RG-8	48’	96’
FOAM RG-8 BELDEN 9913	75’	150’

Source: http://www.audio-technica.com/using/wireless/advanced/cables.html

Shure UA830

- Antennae amp
- Up to 25’ use the 3 dB gain
- Up to 50’ use the 10 dB gain
- May gang two together for more than 50’
- No more than two ganged together



Source: http://www.shure.com/pdf/userguides/guides_wireless/ua830_en.pdf

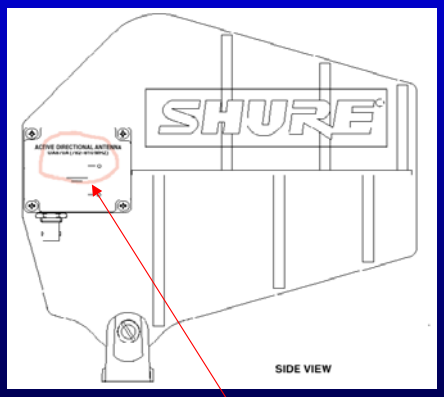
The UA830 is an antennae amplifier. Use only 50 ohm cable.

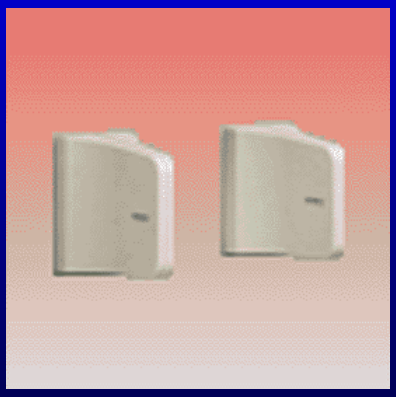
Be sure to put the antennae at the end marked “antennae” and the coax to the end marked “receiver”.

Be sure to check that both the whip and the amp are for the frequency range of the transmitter.

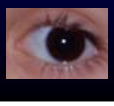
Use the 3 dB setting for 25’ cable and the 10dB setting for the 50’ cable. You can gang together 2 for cables longer than 50’. According to Shure no more than 2 can be ganged together.

Directional Antennae





Look for the frequency range of the antennae.



Directional antennae pick up in a cardioid pattern.

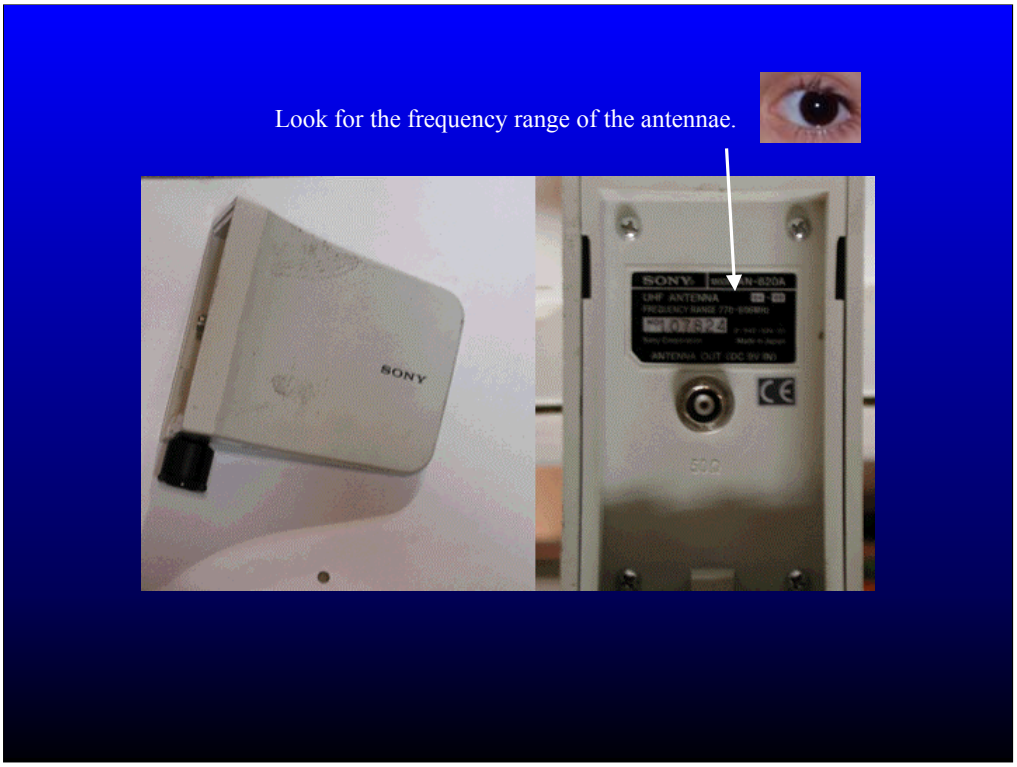
Aim antennae at the receivers.

Use two if possible.

Be sure to check the frequency range of the antennae to see that it matches the frequency range of the transmitters.

The Shure antennae has a gain switch for 3 dB or 10dB. Use the 3 dB setting for 25’ cable and the 10dB setting for the 50’ cable

Use 50 ohm (RG8) coax.



Arrow shows where the frequency range information is located.

Antennae Placement

- Maintain a line- of- sight between the transmitter and receiver antennas.
- Maintain a distance of at least 10 ft between the transmitter and receiver to prevent overloading the receiver.
- Point the antenna tips away from each other at a 45 ° angle.
- Do not let antennae touch.

Source: http://www.audio-technica.com/using/wireless/quicktip/oneplus.html; uhf_en.pdf at www.shure.com

Antennae Placement continued

- Avoid placing antennae where metal or other dense materials may be present.
- Avoid placing the receiver near computers or other RF generating equipment.
- Keep diversity antennae at least 10 inches apart.

Source: http://www.audio-technica.com/using/wireless/quicktip/oneplus.html; uhf_en.pdf at www.shure.com

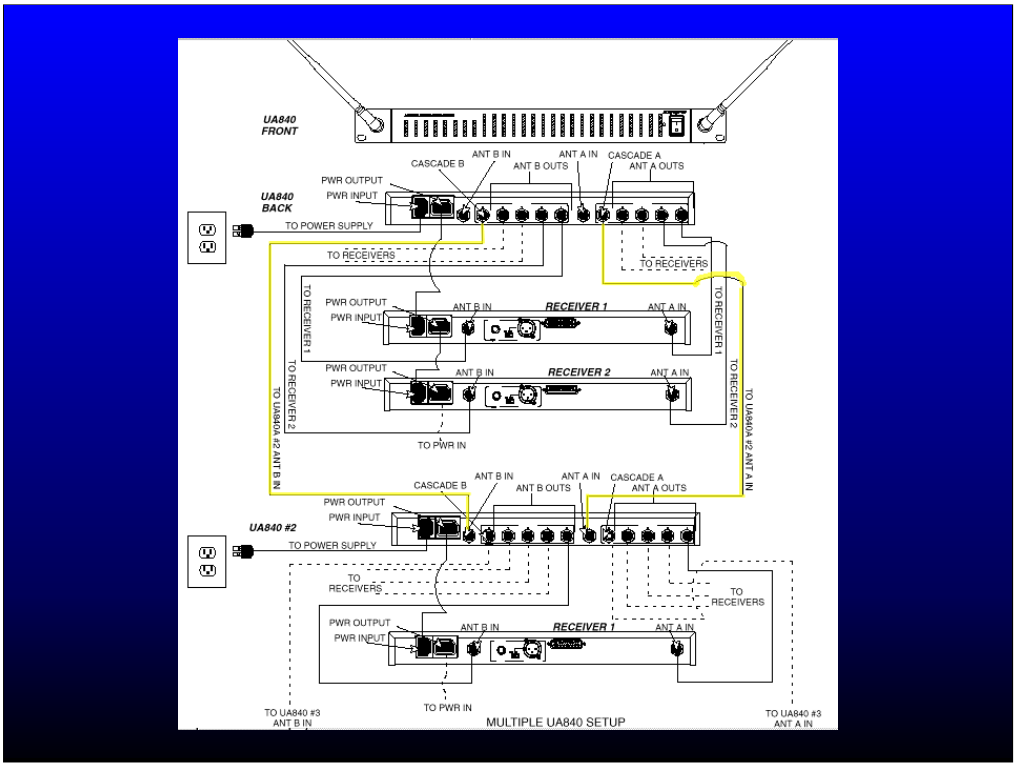
Antennae Dividers or Distros

- Allows several receivers to use just 2 antennae.
- Connect the antennae to the input of the distro.
- Connect the antennae outputs of the distro to the inputs of the different receivers.

Antennae Distros continued

- Terminate unused outputs with 50 ohm BNC terminators (but not inputs!).
- Be sure to check that frequency range is compatible with the rest of the system.
- Turn it on!

Arrow points to where frequency range information is located on the Sony WD-820.



Multiple dividers

Notes from the manual on Sony WD-820A:

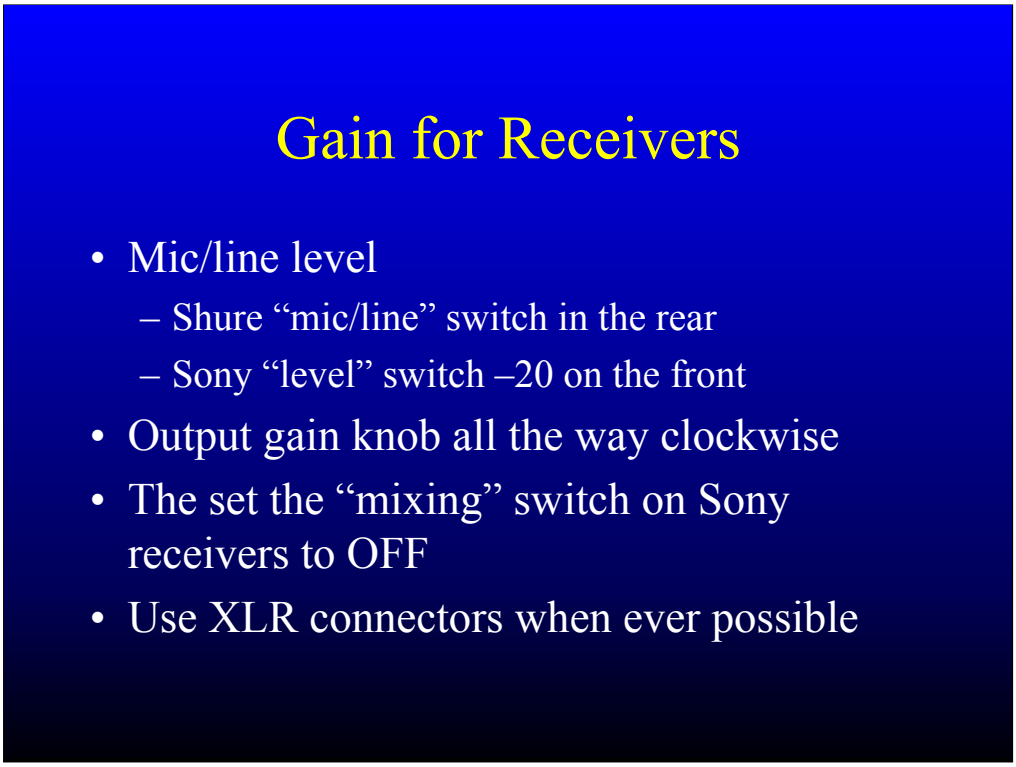
Only 2 or 4 receivers can be connected to the divider.
Do not exceed the 300 W rating of the AC outlet when daisy chaining power.

Notes from the manual on the Shure 840A:

Up to 5 receivers can be connected to divider (outputs 1-4 + cascade).

No more than 5 units can be powered together by daisy chaining AC.

Connecting to the Sound System


Gain for Receivers
• Mic/line level
– Shure “mic/line” switch in the rear
– Sony “level” switch –20 on the front
• Output gain knob all the way clockwise
• The set the “mixing” switch on Sony receivers to OFF
• Use XLR connectors when ever possible

Most receivers will produce a line level signal. The mic level on the receivers is often a pad. Use line level whenever possible so the signal goes through the least possible number of gain stages.

On the Shure, set the “mic/line” switch in the back of the receiver to line level; set the output gain knob on the front right of the receiver fully clockwise.

On the Sony, set the level switch on the front panel to –20 and the level knob to MAX, fully clockwise.

In the rear panel of the Sony, watch out for the “mixing” switch near XLR connector. Be sure this is switched to OFF.

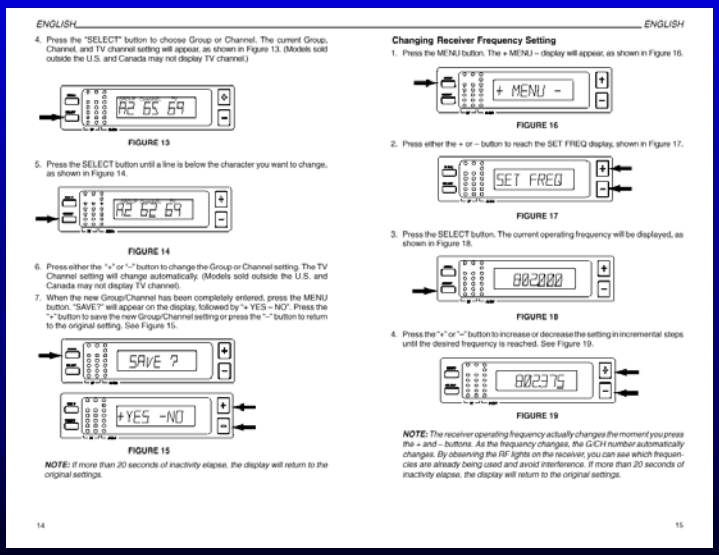
Use the XLR connectors when ever possible.

Sony “Mixing” Switch

Programming Receivers

Shure UHF and Sony UHF 800

Programming Shure Receivers



ENGLISH

4. Press the "SELECT" button to choose Group or Channel. The current Group, Channel, and TV channel setting will appear, as shown in Figure 13. (Models sold outside the U.S. and Canada may not display TV channel.)

FIGURE 13

5. Press the SELECT button until a line is below the character you want to change, as shown in Figure 14.

FIGURE 14

6. Press either the "+" or "–" button to change the Group or Channel setting. The TV Channel setting will change automatically. (Models sold outside the U.S. and Canada may not display TV channel).
7. When the new Group/Channel has been completely entered, press the MENU button. "SAVE?" will appear on the display, followed by "+ YES – NO". Press the "+" button to save the new Group/Channel setting or press the "–" button to return to the original setting. See Figure 15.

FIGURE 15

NOTE: If more than 20 seconds of inactivity elapse, the display will return to the original settings.

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Changing Receiver Frequency Setting

1. Press the MENU button. The + MENU – display will appear, as shown in Figure 16.

FIGURE 16

2. Press either the + or – button to reach the SET FREQ display, shown in Figure 17.

FIGURE 17

3. Press the SELECT button. The current operating frequency will be displayed, as shown in Figure 18.

FIGURE 18

4. Press the "+" or "–" button to increase or decrease the setting in incremental steps until the desired frequency is reached. See Figure 19.

FIGURE 19

NOTE: The receiver operating frequency actually changes the moment you press the + and – buttons. As the frequency changes, the G/CH number automatically changes. By observing the RF lights on the receiver, you can see which frequencies are already being used and avoid interference. If more than 20 seconds of inactivity elapse, the display will return to the original settings.

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Source: uhf_en.pdf at www.shure.com

Program Shure UHF receivers by hitting the “menu” button.

Press the “+” or “-” keys to page through the different choices.

Hit the “select” key when the screen reads the parameter you want to change.

Use the “select” key and the “+” or “-” keys to change the parameter.

Once the program is set, hit the “menu” button again.

The screen will read “SAVE ?”; hit the “+” key to save.

If you do not save the receiver will revert back to the previous settings in 20 seconds.

Programming Sony Receivers

Program the Sony UHF 800 receiver by holding down the “set” button and then hitting the “group” button.

Each time you hit the “group” button, you cycle through the first channel of each group (00, 11, 12, 13, A1, A2 & A3).

Let go of the group button on the selection you want.

Hold down the “set” button again and hit the “channel” button to cycle through the possible channels within the group.

Choosing Frequencies

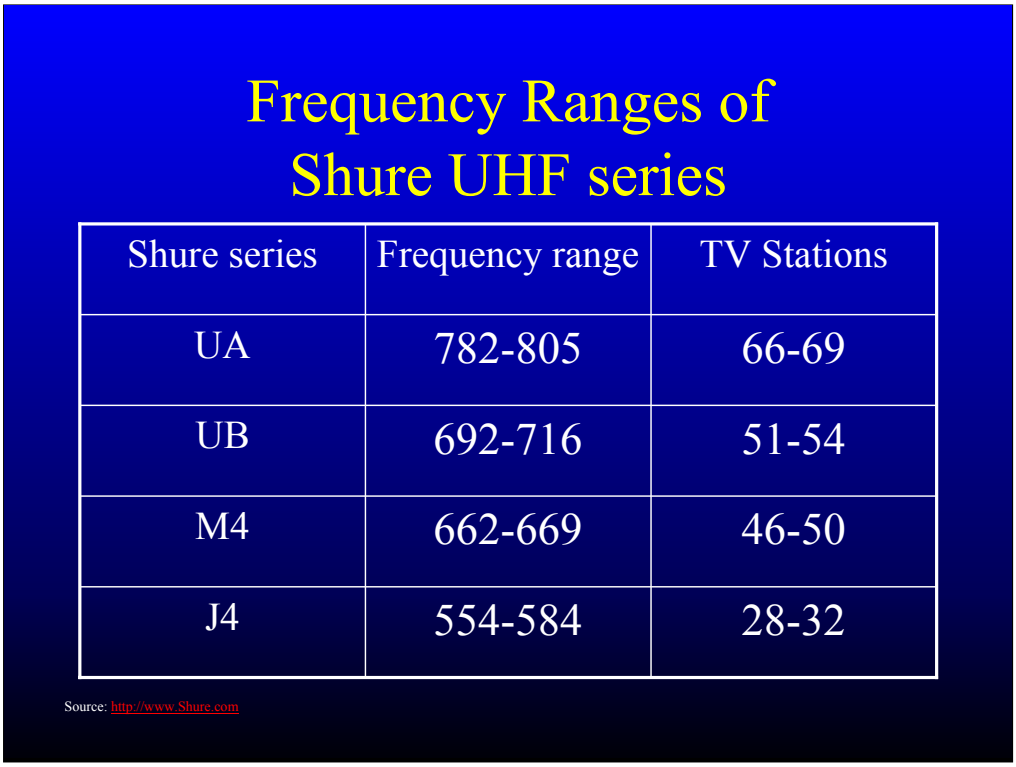
Frequency Bands

Frequency	Band Number	Classification	Abbreviation
30 - 300 Hz	2	Extremely Low Frequencies	ELF
300 - 3000 Hz	3	Voice Frequencies	VF
3 - 30 KHz	4	**Very Low Frequencies**	**VLF**
30 - 300 KHz	5	Low Frequencies	LF
300 - 3000 KHz	6	Medium Frequencies	MF
3 - 30 MHz	7	High Frequencies	HF
30 - 300 MHz	8	Very High Frequencies	VHF
300 - 3000 MHz	9	**Ultrahigh Frequencies**	**UHF**
3 - 30 GHz	10	Super-High Frequencies	SHF
30 - 300 GHz	11	Extremely High Frequencies	EHF
300 GHz - 3 THz	12	-	-

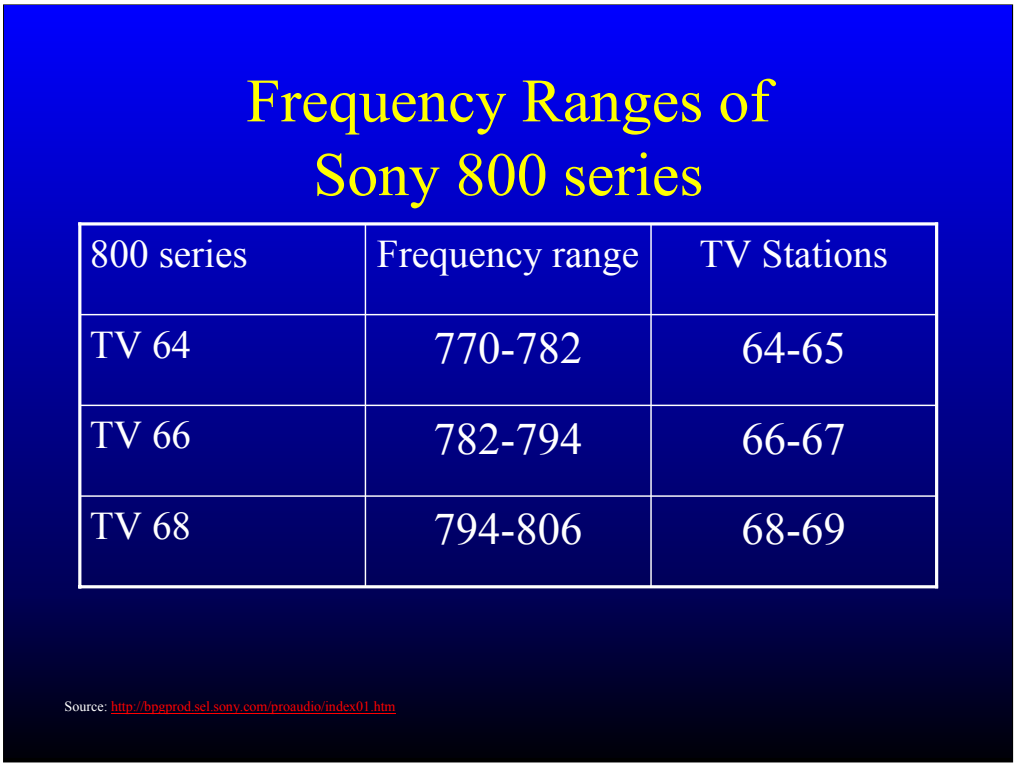
Source: http://www.testeq.com/charts/freqclas.lasso

Human hearing is 20 Hz to 20 kHz.

UHF is 300 MHz to 3000 MHz.



The Shure UHF currently has 4 series. The “UA” series is the original and covers 782-805mega Hertz in TV channels 66-69. The “UB” series goes from 692-716 mega Hertz in TV channels 51-55. The “M4” series is 662-669 mega Hertz in TV channels 46-50. The “J4” series is 554-584 mega Hertz in TV channels 28-32.



The Sony 800 UHF come in three TV channels, 64/65 (770 MHz to 782 MHz) , 66/67 (782 MHz to 794 MHz), and 68/69 (794 MHz to 806 MHz). The total carrier coverage is between 770 and 806.

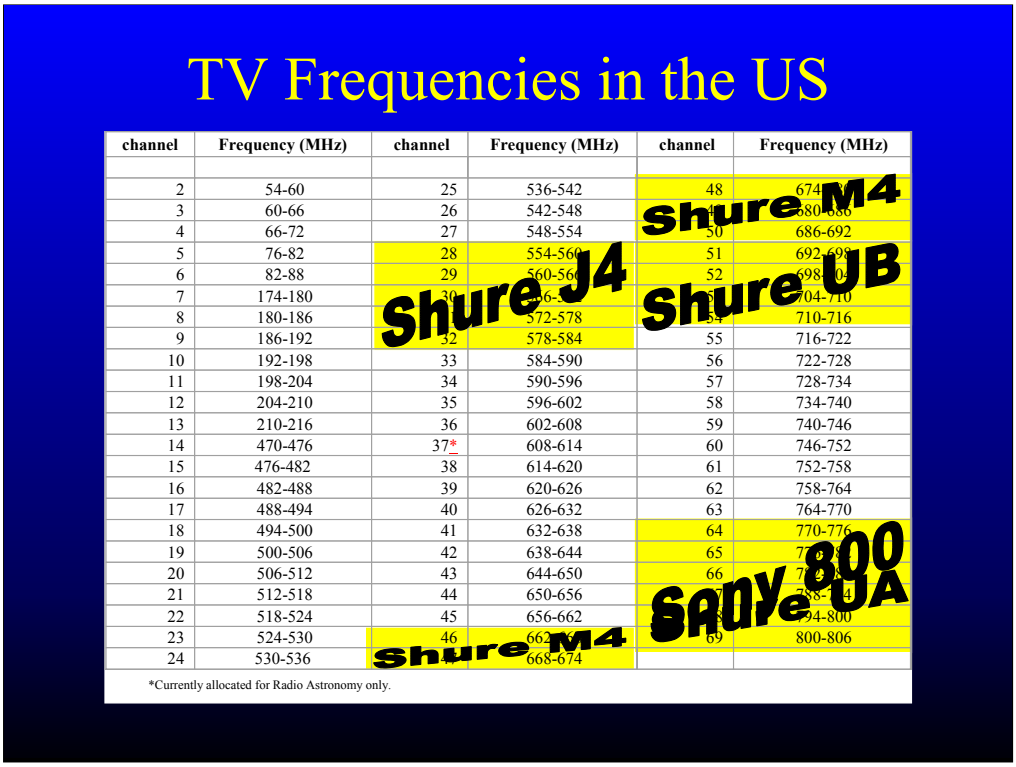
Other brands cover other ranges.

TV Frequencies in the US

channel	Frequency (MHz)	channel	Frequency (MHz)	channel	Frequency (MHz)
2	54-60	25	536-542	48	674-680
3	60-66	26	542-548	49	680-686
4	66-72	27	548-554	50	686-692
5	76-82	28	554-560	51	692-698
6	82-88	29	560-566	52	698-704
7	174-180	30	566-572	53	704-710
8	180-186	31	572-578	54	710-716
9	186-192	32	578-584	55	716-722
10	192-198	33	584-590	56	722-728
11	198-204	34	590-596	57	728-734
12	204-210	35	596-602	58	734-740
13	210-216	36	602-608	59	740-746
14	470-476	37*	608-614	60	746-752
15	476-482	38	614-620	61	752-758
16	482-488	39	620-626	62	758-764
17	488-494	40	626-632	63	764-770
18	494-500	41	632-638	64	770-776
19	500-506	42	638-644	65	776-782
20	506-512	43	644-650	66	782-788
21	512-518	44	650-656	67	788-794
22	518-524	45	656-662	68	794-800
23	524-530	46	662-668	69	800-806
24	530-536	47	668-674		

*Currently allocated for Radio Astronomy only.

Source: http://www.flyingwombat.com/usa_tv_freqs.html



The yellow highlight shows the frequency ranges that the Shure UHF and Sony UHF 800 uses in comparison to television stations in the US.

Bay Area TV and Sony/Shure frequencies

channel	Frequency (MHz)	channel	Frequency (MHz)	channel	Frequency (MHz)
2	54-60	25	536-542	48	Free?
3	60-66	26	542-548	49	KSTS-DTV SJ
4	66-72	27	548-554	50	KFTY-SANTA ROSA
5	76-82	28	Free?	51	KDTV-DTV SF
6	82-88	29	KPIX-DTV SF	52	KICU-DTV SJ
7	174-180	30	KQED-DTV SF	53	Free?
8	180-186	31	Free?	54	KTEH SJ/KFTY DTV SR
9	186-192	32	KMTP SF	55	716-722
10	192-198	33	584-590	56	722-728
11	198-204	34	590-596	57	728-734
12	204-210	35	596-602	58	734-740
13	210-216	36	602-608	59	740-746
14	470-476	37*	608-614	60	746-752
15	476-482	38	614-620	61	752-758
16	482-488	39	620-626	62	758-764
17	488-494	40	626-632	63	764-770
18	494-500	41	632-638	64	Free?
19	500-506	42	638-644	65	KLXV SJ
20	506-512	43	644-650	66	KPST SF
21	512-518	44	650-656	67	Free?
22	518-524	45	656-662	68	KWOK-NOVATO
23	524-530	46	Free?	69	Free?
24	530-536	47	KWOK-DTV NOVATO		

*Currently allocated for Radio Astronomy only.

Source: http://www.lns.com/sbc/Bay_Area_TV.html

Warning: This information may be incorrect or outdated. Find out for yourself what TV stations are operating in the area!

Shure M4 example

To maximize the number of compatible wireless systems in a given area, eliminate the frequencies that are occupied by local TV Channels, and then use the group with the most remaining available (open) frequencies.

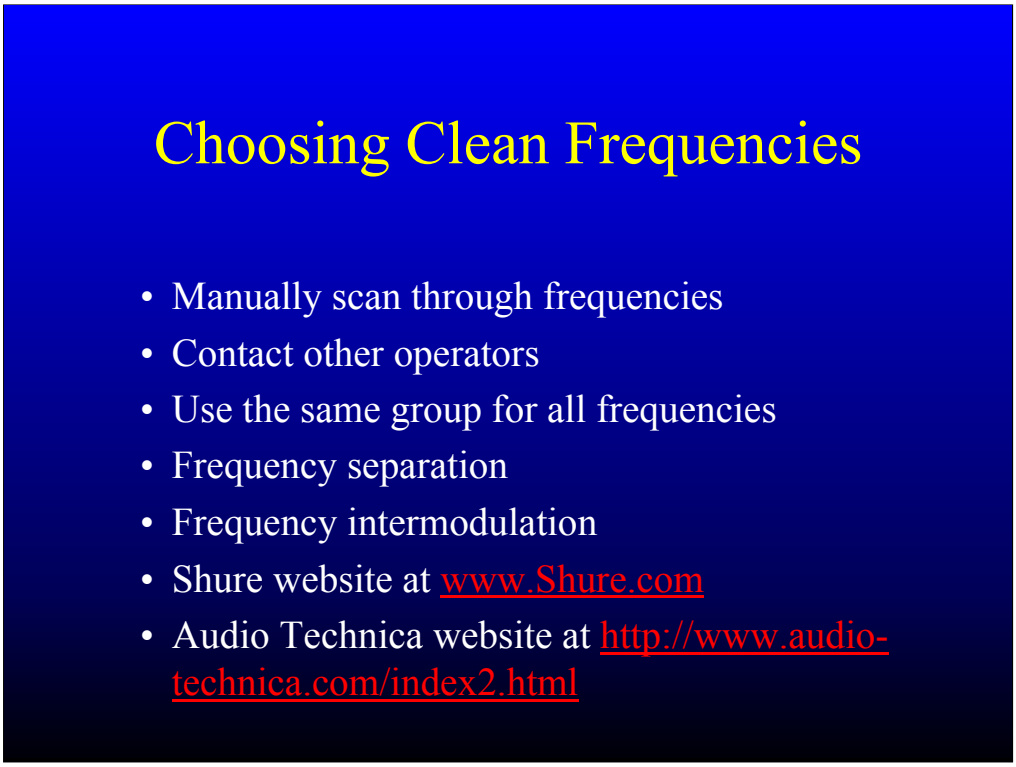
Compatibility Group 1			This frequency is in US TV Channel:
Ch. 1	662.150	MHz	TV 46
Ch. 2	662.825	MHz	
Ch. 3	663.700	MHz	
Ch. 4	665.600	MHz	
Ch. 5	666.325	MHz	
Ch. 6	668.025	MHz	TV 47
Ch. 7	669.500	MHz	
Ch. 8	671.000	MHz	
Ch. 9	671.875	MHz	
Ch. 10	674.575	MHz	TV 48
Ch. 11	675.325	MHz	
Ch. 12	677.775	MHz	
Ch. 13	678.500	MHz	
Ch. 14	679.500	MHz	
Ch. 15	681.000	MHz	
Ch. 16	682.425	MHz	TV 49
Ch. 17	683.875	MHz	
Ch. 18	684.825	MHz	
Ch. 19	686.550	MHz	
Ch. 20	687.075	MHz	
Ch. 21	688.725	MHz	TV 50
Ch. 22	689.725	MHz	
Ch. 23	690.500	MHz	
Ch. 24	691.075	MHz	

Compatibility Group 2			This frequency is in US TV Channel:
Ch. 1	662.025	MHz	TV 46
Ch. 2	663.025	MHz	
Ch. 3	663.650	MHz	
Ch. 4	666.000	MHz	
Ch. 5	667.200	MHz	
Ch. 6	669.475	MHz	TV 47
Ch. 7	670.500	MHz	
Ch. 8	671.1	MHz	
Ch. 9	671.9	MHz	
Ch. 10	673.175	MHz	TV 48
Ch. 11	674.150	MHz	
Ch. 12	674.650	MHz	
Ch. 13	675.625	MHz	
Ch. 14	678.400	MHz	
Ch. 15	679.6	MHz	
Ch. 16	681.25	MHz	TV 49
Ch. 17	682.425	MHz	
Ch. 18	683.825	MHz	
Ch. 19	686.550	MHz	
Ch. 20	687.0	MHz	
Ch. 21	687.8	MHz	TV 50
Ch. 22	689.0	MHz	
Ch. 23	690.550	MHz	
Ch. 24	691.475	MHz	

Compatibility Group 3			This frequency is in US TV Channel:
Ch. 1	662.225	MHz	TV 46
Ch. 2	662.800	MHz	
Ch. 3	663.800	MHz	
Ch. 4	664.575	MHz	
Ch. 5	665.150	MHz	
Ch. 6	666.000	MHz	
Ch. 7	667.125	MHz	
Ch. 8	668.225	MHz	TV 47
Ch. 9	669.200	MHz	
Ch. 10	670.225	MHz	
Ch. 11	671.225	MHz	
Ch. 12	678.025	MHz	TV 48
Ch. 13	678.450	MHz	
Ch. 14	679.350	MHz	
Ch. 15	681.050	MHz	
Ch. 16	681.900	MHz	TV 49
Ch. 17	682.800	MHz	
Ch. 18	683.775	MHz	
Ch. 19	685.700	MHz	
Ch. 20	685.575	MHz	
Ch. 21	686.925	MHz	TV 50
Ch. 22	688.400	MHz	
Ch. 23	689.450	MHz	
Ch. 24	690.475	MHz	

KWOK-NOVATO
KSTS-DTV SAN JOSE
KFTY-SANTA ROSA

Source: http://www.Shure.com


Choosing Clean Frequencies
• Manually scan through frequencies
• Contact other operators
• Use the same group for all frequencies
• Frequency separation
• Frequency intermodulation
• Shure website at www.Shure.com
• Audio Technica website at http://www.audio-technica.com/index2.html

Manually punch through all the frequencies you want to use with the transmitters off to see if you have any traffic.

Contact other operators in the area and coordinate with them so you are not on or near their frequencies.

On both the Shure UHF and Sony UHF 800, all channels within a group do not overlap, but different groups do overlap. Use channels within the same group to avoid overlapping.

When using frequencies besides the preprogrammed groups, try to separate frequencies by at least .5 MHz to avoid “stepping on”.

Also when using frequencies besides the preprogrammed groups, don’t use frequencies at regular intervals to avoid intermodulation.

Check out the Shure website and the Audio Technica website.

Groups, Channels and TV stations on Shure and Sony

- Both Shure and Sony group frequencies that do not intermodulate. Each group is a collection of channels (frequencies).
- The groups are built around TV channels.
- Choose channels within the same group so frequencies will not overlap or intermodulate.
- Sony TV Channel 66 and TV Channel 68 overlap Shure series “UA”.

Master Groups

- The master groups are groups of channels that access every frequency available on the device.
- Shure master groups are designated by the letter A. For example A1, A2, A3, ect.
- The Sony master group is 00 group.
- Because the master group channels are every frequency, they will intermodulate. Be careful when using them.

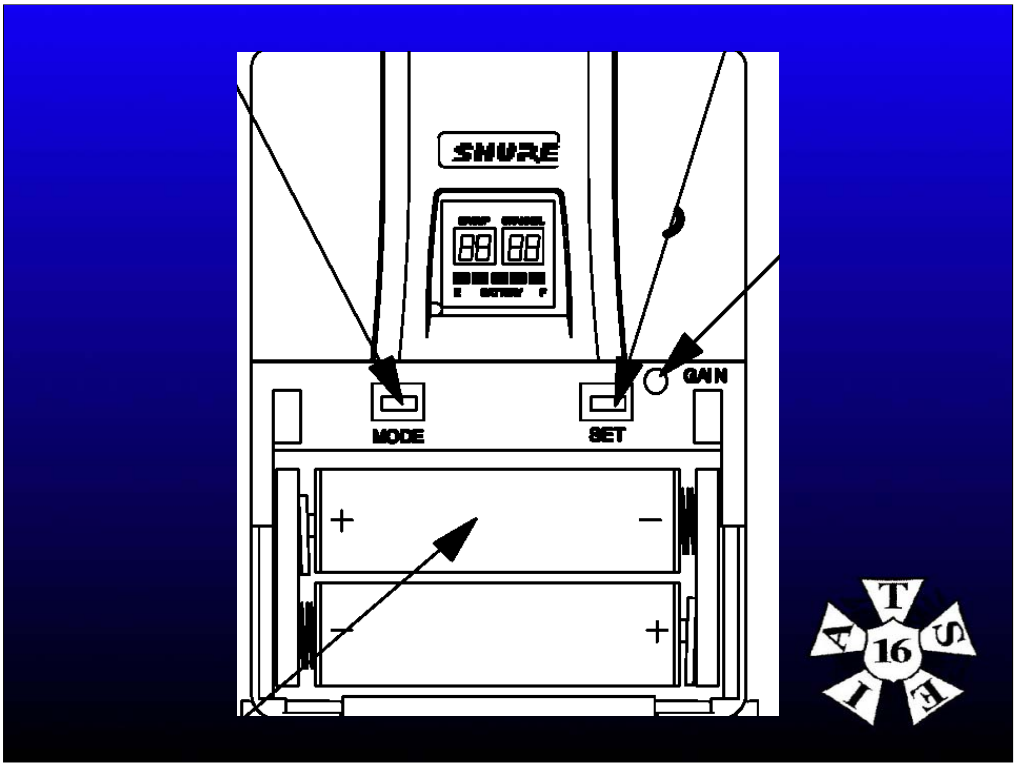
Example of Cross Frequencies

			Specific TV Groupings-- Cannot use cross group mix			No TV Present	Even # TV Present	Odd # TV Present	No TV Present			TV 66 Present	TV 67 Present	TV 68 Present	TV 69 Present
SHURE	SONY	FREQ	Sony 11	Sony 12	Sony 13	Sony A-1	Sony A-2	Sony A-3	Shure 1	Shure 2	Shure 3	Shure 4	Shure 5	Shure 6	Shure 7
A1/1	66-1	782.125													7-1
A1/2	66-2	782.250				A1-6									
A1/3	66-3	782.375			66/67 13-1										
A1/4	66-4	782.500													
A1/5	66-5	782.625	66/67 11-1								3-1		5-1		
A1/6	66-6	782.750						A3-4	1-1						
A1/7	66-7	782.875													
A1/8	66-8	783.000													7-2
A1/9	66-9	783.125								2-1	3-2			6-1	
A1/10	66-10	783.250													
A1/11	66-11	783.375							1-2						
A1/12	66-12	783.500													
A1/13	66-13	783.625			66/67 13-2										7-3
A1/14	66-14	783.750	66/67 11-2							2-2				6-2	
A1/15	66-15	783.875									3-3				
A1/16	66-16	784.000													
A1/17	66-17	784.125													
A1/18	66-18	784.250			66/67 13-3								5-2		

Source: Spread sheet by Jim Risgin of On Stage Audio

This spreadsheet shows how different groups/channels of the 2 brands can share the same frequency.

Transmitters and Mics



Programming Shure transmitter:

a. Press and hold down the MODE button until only the Group number is displayed,

b. Press the SET button to increment the Group setting.

c. Press the MODE button again so that only the Channel number is displayed. Press the SET button to change the Channel setting.

d. Press the MODE button again so that the new Group and Channel numbers are both displayed. Now the new settings are saved.

Shure Transmitters

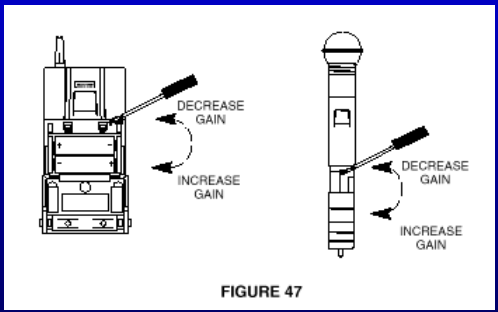
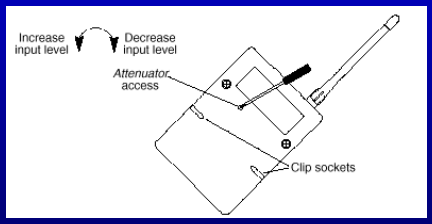


FIGURE 47

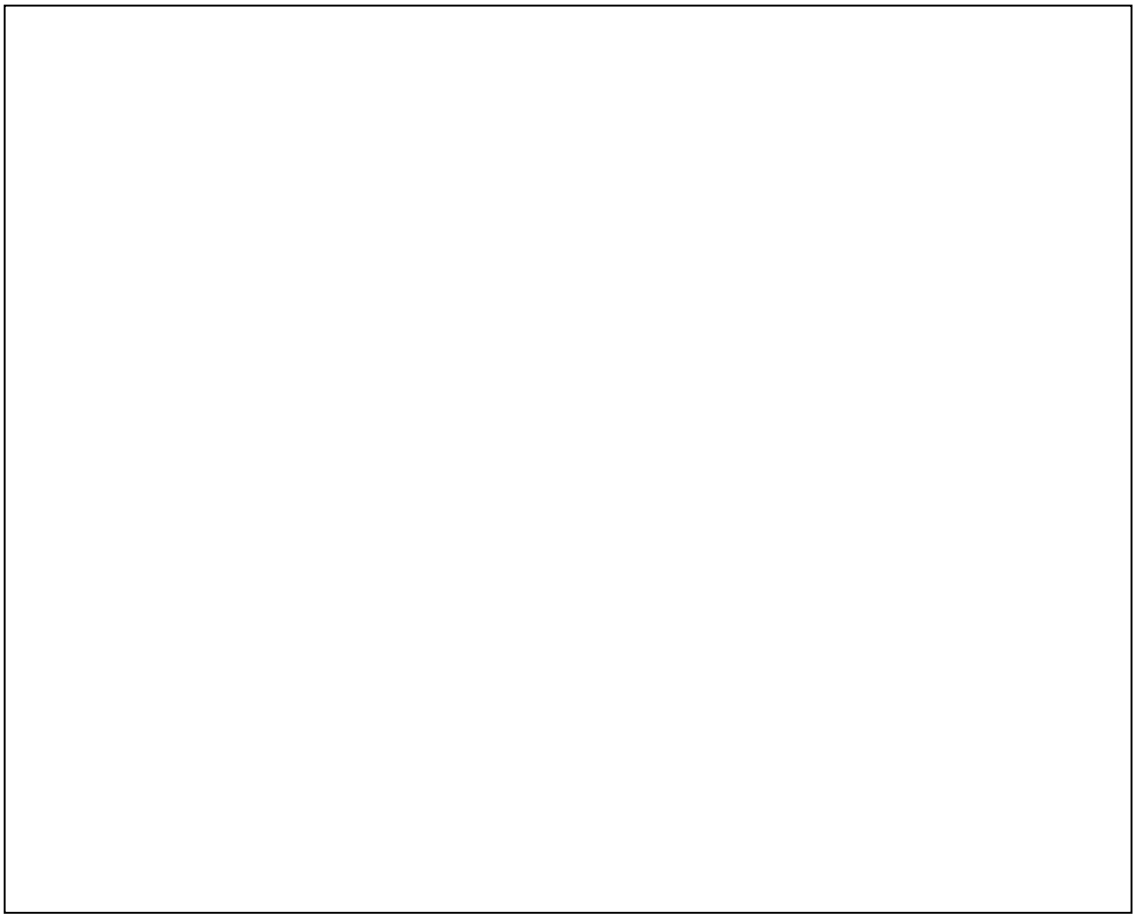
Start with gain all the way down



Start attenuator at –6

Power Lock and Frequency Lock on Shure Transmitters

- Power Lock :
  - Press and hold the SET button, then press and hold the MODE button. Hold both keys down until “PoL” (for power locked) is displayed.
  - To unlock , repeat the steps.
- Frequency Lock :
  - Turn the transmitter power off.
  - Turn the power back on while holding down the SET button until the fuel gauge on the transmitter is active. “Fr L” will appear momentarily, until you release the SET button.
  - To release, repeat steps.



Programming Sony transmitter WRT-820A:

a. With a small tweeker or pin, push down the indented SET button while switching on the belt pack.
b. Press the +or- to change the channels.
c. Set the power switch to off to save the setting.

Setting the gain:

a. Push on the SET button to cycle the channel display or attenuation display.
b. In the attenuation display mode, press the + or - buttons to change the attenuation.
c. 6 dB is usually a good place to start.

Tape over the power switch.

Transmitter Gain

- Wireless mics use compander circuitry to compress and expand the audio signal.
- To maximize the compander circuit set the transmitter gain to as high as possible without overmodulating on the loudest sounds.

Lavalier Mics

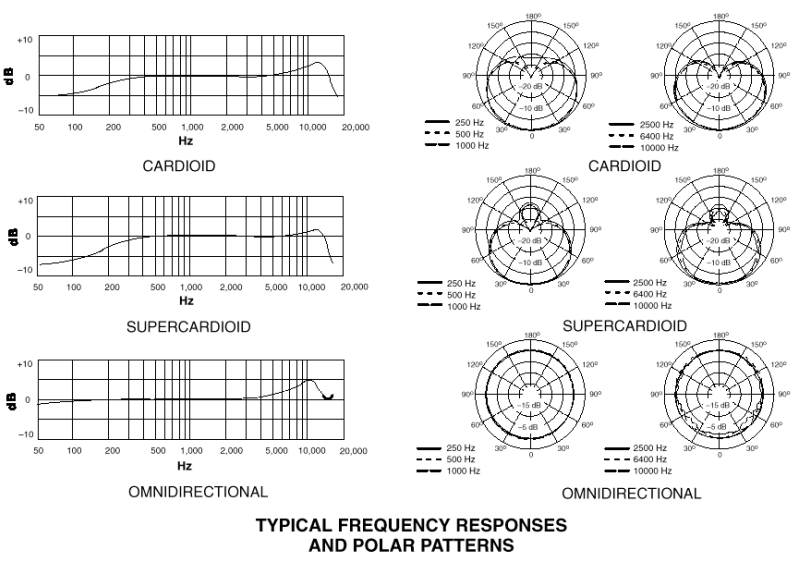
- Mic selection
  - Cardioid: Shure mx185
  - Hyper Cardioid: Shure mx184, sennheiser 104
  - Omni: Shure mx183, sennheiser mke2, countryman trams

The A1 will usually pick the mics to be used.

Go through the package to determine which mics are available.

Pull off the windscreens to check out the brand and model of mics.

Polar Patterns of Mics



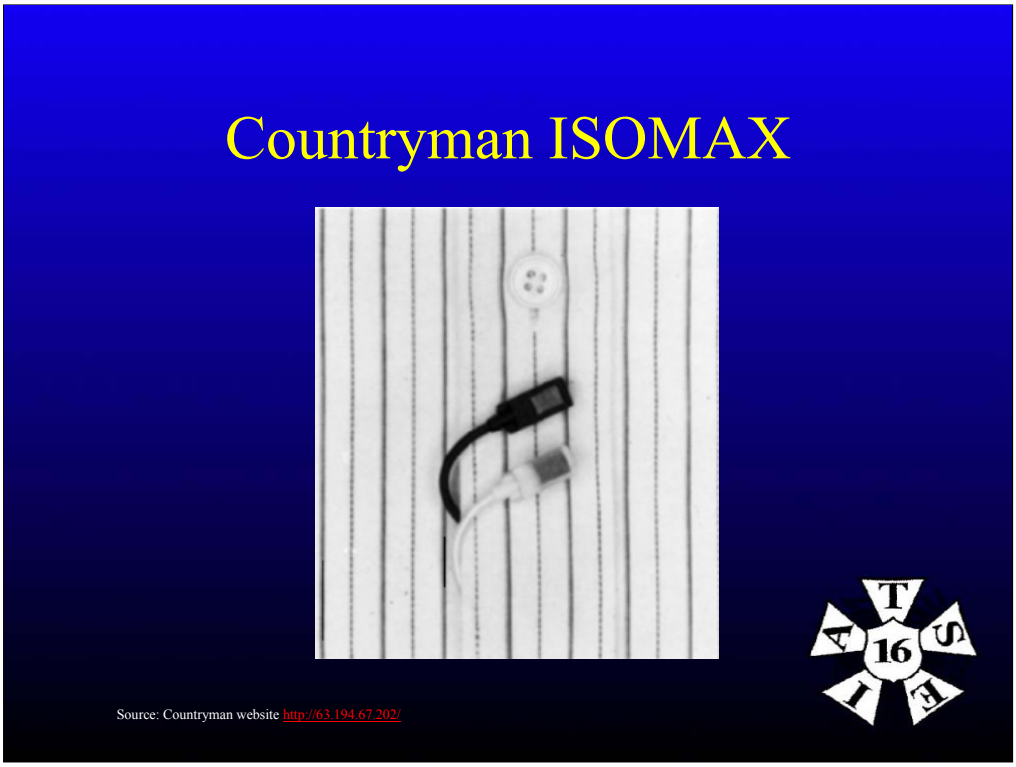
TYPICAL FREQUENCY RESPONSES AND POLAR PATTERNS

Sennheiser Lavalier Mics

mke 104

mke 2

Source: www.sennheiserusa.com



Countryman ISOMAX EMW omni lavalier mic

Check for Failures

- Windscreen
- Mic Capsule
- Exercise the connections of both mic and antennae
- Seat batteries firmly or tape them in
- When using “combo packs”, make sure that only the handheld or the belt pack programmed to the same frequency is on at one time.

- Walk the room to check for RF dropouts
- Test every mic on stage through the speakers before the audience arrives

Mic and Belt pack Placement

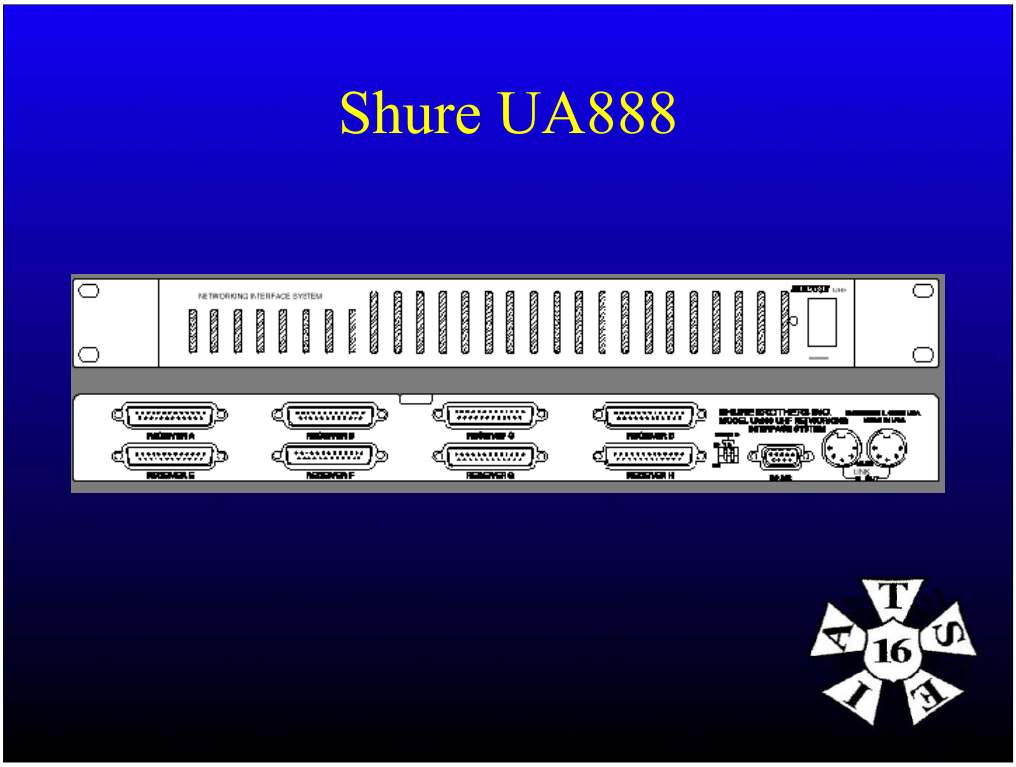
- Have talent remove badge and/or jewelry that may hit mic
- Clip mic just under tie in the center of the body
- Some clips can be rotated
- Leave a little slack if dressing through clothing
- Turn off cell phone
- When double micing, place belt packs on either side of back

Batteries

- Count the battery inventory at load in and estimate how many you may need for the run.
- Use fresh batteries for every show.
  - Remove all batteries from all transmitters and put in a box or away.
  - Put fresh batteries in each transmitter.
  - Turn on each transmitter one at a time and verify at the receiver.
- Return unused batteries to the vendor.

Other Topics

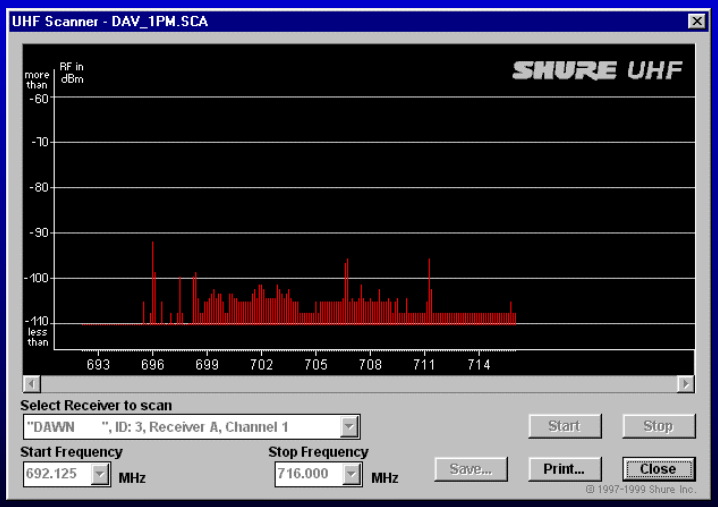
Shure Scanning Software



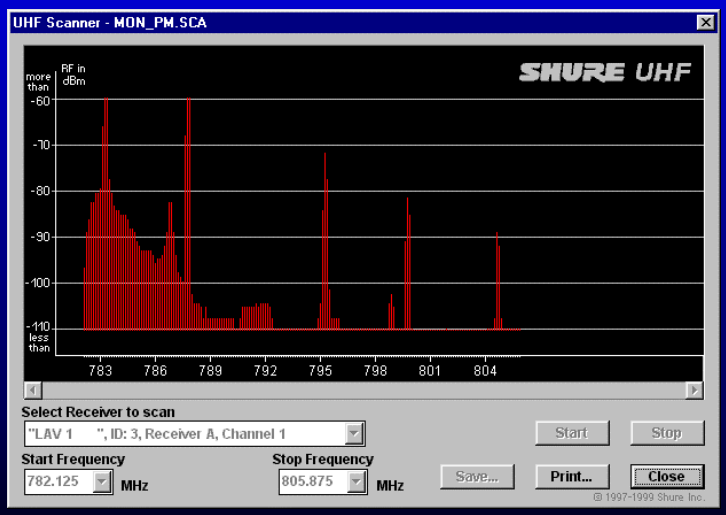
The Shure UA888 is a network interface for the Shure UHF receivers.

Connect all the receivers network plugs to the UA888 and connect the computer through the com port.

UA888 Software



UA888 Software



Resources on the Web

- Audio-Technica http://www.audio-technica.com/
- Sennheiser http://www.sennheiserusa.com/
- Shure Brothers http://www.shure.com/

- http://www.local16.org
- lisa@pink-noise.com

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